LIME AND DOLOMITE

Lime and dolomite are naturally occurring minerals. They are crushed (pulverised) and used in agriculture to change physical and chemical aspects of the soil, improving early plant growth while improving intensively managed agricultural land.

When soils are acidic, plant growth is limited as aluminium becomes increasingly available due to declining soil pH reducing early root prefoliation. In turn liming materials are applied to increase soil pH reducing the effects of aluminium toxicity and improve soil fertility. Some of the soil characteristics that may be improved by their use are:

- correction of low soil pH (acidity).
- soil levels of calcium and magnesium.
- availability of some other plant nutrients, e.g., phosphorus and molybdenum; and
- the activities and populations of some soil micro-organisms.

1. LIMING MATERIALS

Liming materials contain calcium and magnesium in the carbonate, oxide, or hydroxide forms. In addition to supplying calcium and magnesium, they correct soil acidity by raising the soil pH. Naturally occurring limestones, from which limes are prepared, vary greatly in their composition, purity, and hardness. Pure limestone or calcite is calcium carbonate ($CaCO_3$). Most limestones also contain some magnesium carbonate ($MgCO_3$) or magnesite. These materials are referred to as dolomitic limestones.

The chemical formula of the more common minerals or ores are listed in Table 1.

Table 1: Chemical formula of the more common minerals or ores.

Common name	**Chemical name**	**Formula**
Lime (calcite)	Calcium carbonate	$CaCO_3$
Dolomite	Calcium magnesium carbonate	$CaMg(CO_3)_2$
Magnesite	Magnesium carbonate	$MgCO_3$

Some limestones contain silicates, as well as carbonates of calcium and magnesium. Serpentine or magnesium silicate is highly insoluble. Limestones vary in their hardness and porosity. Chalk, for example, is soft and porous, while marble, a metamorphic rock that is formed when limestone is subjected to heat and pressure, is much harder. Soft limes can be excavated directly from the quarry, whilst hard crystalline limestone requires mining using explosives. Both soft and hard limestones require further processing before they can be applied to the soil. Usually this is confined to crushing the limestone to produce Pulverised or Agricultural Lime.

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Limestone is relatively insoluble, so a fine particle is essential. The finer the particle size, the faster the product will react in the soil. For a given weight of lime, fine particles present a larger surface area for water and soil contact than coarse particles. At the same particle size, soft limes are more reactive than hard limes. Colours vary from white (pure) to pink, brown, yellow, or grey, being derived from impurities within the mineral or from contamination further processing is done to improve the reactivity of the final product.

Burnt Lime (CaO) is produced by heating Limestone ($CaCO_3$). Burnt Lime is caustic and must be handled with care.

$$CaCO_3 \rightarrow CaO + O_2$$

If burnt lime (CaO) is allowed to absorb water (H_2O), it forms calcium hydroxide or **Slaked Lime** [$Ca(OH_2)$].

$$CaO + H_2O \rightarrow Ca(OH_2)$$

As well as having a fine particle size, Burnt Lime and Slaked Lime are more soluble than Pulverised Lime. Their solubility approaches that of Gypsum. Burnt and Slaked Lime are sparingly soluble, whereas Pulverised Lime (calcium carbonate) is virtually insoluble. Calcium carbonate is one hundred times less soluble than burnt lime, slaked lime and gypsum (calcium sulfate).

Table 2: Solubility of various calcium salts in water at 20^0C, unless otherwise specified. Source: Lange's Handbook of Chemistry,13th Ed.

Common name	**Chemical name**	**Formula**	**Solubility (kg/100L)**
Lime (calcite)	Calcium carbonate	$CaCO_3$	0.0014
Burnt Lime	Calcium oxide	CaO	0.13^{25}
Slaked Lime	Calcium hydroxide	$Ca(OH)_2$	0.17
Gypsum	Calcium sulfate	$CaSO_4.2H_2O$	0.26

2. LIME QUALITY

The effectiveness of liming materials depends on their purity, the form in which calcium and magnesium are present, the particle size, and the porosity (softness). Australian State Legislation on Liming Materials varies, but generally requires that information be provided on the following:

- the amount calcium (Ca) and magnesium (Mg) present (guaranteed minimum percentage).
- the forms (carbonate, oxide, hydroxide, silicate) in which the Ca and Mg are present.
- the Neutralising Value.
- particle size (proportions of fine and coarse particles).

Calcium levels range from 64% in burnt lime to 13% in dolomite. The magnesium levels range from trace levels in true limestone to 8% in dolomite and 26% in magnesite. Lime and dolomite have the

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calcium and magnesium totally in the carbonate form. Other liming materials such as serpentine and cement contain some or all the calcium and magnesium as silicates.

Fine lime is highly desirable. The finer the particle size of the liming material the more rapidly it reacts with the hydrogen ions neutralizing acidity. Fine lime particles are also able to achieve a greater surface area and due to the inherent low solubility of many lime sources. Fine lime desirable for incorporation and mixing through tillage and seeding equipment to further increase contact between the liming material and soil surface.

Neutralising Value compares the ability of the product to neutralize acidity with pure calcium carbonate ($CaCO_3$), which is used as a standard and given a value of 100. Pulverised Lime may contain impurities of earthy material from quarry over-burden, so the neutralizing value can vary from 70 to 100. Calcium oxide or burnt lime has a neutralizing value of 160.

Regulatory requirements on particle size vary. For example, in Qld, the degree of fineness must be stated, i.e., proportion (%) of the product with a particle size less than 250 microns (µm). In some States, the amount of lime that falls into the following categories is determined:

- Fine < 300µm.
- Medium 300 – 850 µm.
- Coarse > 850 µm.

From this, the **Effective Neutralising Value** can be determined. The Effective Neutralising Value takes the particle size distribution and Neutralising Value into consideration, being the sum of:

- Neutralizing Value X Proportion (%) in the Fine Range.
- Neutralizing Value X Proportion (%) in the Medium Range X 0.6.
- Neutralizing Value X Proportion (%) in the Coarse Range X 0.1.

In South Australia, Lime is then classified as:

- Grade 1 Effective Neutralizing Value > 80%.
- Grade 2 Effective Neutralizing Value > 65%.
- Grade 3 Effective Neutralizing Value > 50%.

In Victoria, the Effective Neutralizing Value no longer must be stated on the label, as it does not take into consideration the porosity or softness on the limestone. Comparing the Effective Neutralizing Value for a soft lime versus a hard lime can be misleading. 90% of the lime products sold in Victoria are referred to as soft limes.

3. PREDICTING LIME REQUIREMENTS

Many factors need to be considered when determining the need for lime, and the rate at which it should be applied. Soil tests, for example, tell how acid the soil is, but do not reliably indicate how much lime to apply. The extent of these changes is dependent on the soil cation exchange capacity (CEC), buffering capacity and soil organic matter content. Crop tolerance of acidity, the value of the crop being grown, depth of incorporation, and the quality of the lime (fineness and purity) are factors

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that need to be considered. Depending on the soil's acidity and the rate of application, an application of lime can remain effective for several years. It does not normally have to be applied every year.

The range of crops grown in the rotation should be considered, as well as when will be the best time to apply the lime. Normally this will be before planting the crop with the highest value or least tolerance of acidity, e.g., canola in a grain crop rotation. In pasture crop rotations, lime should be applied during the cropping phase, so that the lime can be incorporated into the soil. Where reduced tillage is practised, lime should be applied at a time when a cultivation or full seedbed preparation is planned. High rates of lime are normally used in horticultural crops. Compared to most broadacre crops, fruit and vegetable crops are usually less tolerant of soil acidity and more responsive to calcium. Their high value demands that risks not be taken. It is better to on the safe side than to risk yield and quality loss due to soil acidity or calcium deficiency. Where vegetables are grown, the soil is normally cultivated to a greater depth than for most other crops. Higher rates of lime are required, as it will be diluted in a greater volume of topsoil.

3.1. pH

Soil pH is a measure of acidity and alkalinity of the soil solution. Soil pH is measured in two ways, in a 1:5 soil: water suspension (pH_w), and in a 1:5 soil:0.1 M $CaCl_2$ solution (pH_{Ca}). In some districts, often for historical reasons, one of these tests is preferred to the other. The pH_w range for most soils is 4.5 to 8.5. Lower values, down to 3.5, are usually associated with peaty soils or severely leached acid soils. Higher values, up to 9.5, are associated with high levels of exchangeable sodium and free calcium carbonate. A pH_w of 7.0 is neutral. pH_{Ca} results are usually 0.2 to1.0 unit lower than pH_w, although this can vary. The difference is wider in alkaline soils in which free lime is present. Generally, the higher the salt content the closer the two pH values will be.

Ideally, the soil pH_w should be in the range of 6.0 – 7.5, but many crops will grow quite satisfactory outside this range. Sugarcane, for example is responsive to calcium, but tolerates acidity. Sometimes, it is best to maintain the pH outside this range, e.g., in potatoes, the incidence of the fungal disease Powdery Scab increases above a pH of 5.5. In high rainfall areas, the subsoil is often more acid than the topsoil, while in arid areas it is usually more alkaline. The rate at which subsoil acidification occurs in high rainfall areas increases markedly if the pH_w of the topsoil can fall below 5.5. Even if crops or pastures are being grown that are tolerant of soil acidity, it is wise to maintain the pH_w of the topsoil above 5.5 if at all practical. Once acidity has developed at depth, it is very difficult and takes a long time to correct.

Raising and maintaining the pH_w above 5.5 may not be possible on peaty soils (with a high organic matter content). While useful in assessing the suitability of soil for plant growth, soil pH tests do not reliably indicate the amount of lime required to raise the soil pH to a more acceptable level. Extractable calcium, magnesium, aluminium, and manganese concentrations should also be considered in determining lime requirements. As a rule of thumb, the pH of a medium textured soil (loam) can be moved by 0.5 of a pH unit by 2.5 t/ha of lime. Less lime is required in sands and more in clays.

The following table can be used as a general guide on the amount of lime to apply in different cropping situations. Considerable variation in lime recommendations exists between crops and regions.

Lime (calcium carbonate) is only recommended if the pH_w is below 6.5. Pulverised Lime will not react in the soil if it is neutral to alkaline. Soils in which calcium is low and the pH_w is above 6.5 in its natural state are not common. If they are encountered, alternative more soluble calcium fertilisers should be used. Sometimes, light textured naturally acidic soils that have a recent history of liming will be found to be low in calcium but to have a pH_w above 6.5. This does not mean that lime no longer needs to be applied, and that some other product should be used in its place. Lime will continue to be required as

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part of a balanced fertiliser program on such soils if high rates of nitrogen fertiliser are applied or legumes are grown. If lime is not used regularly, the soil will once again become acid.

To safeguard against excessive increases in soil pH, and induced deficiencies of other nutrients, it is usually recommended that no more than 2.5 t/ha of lime be applied per application on sands, or 5 t/ha on clays, where horticultural crops (fruit and vegetables) are grown. Higher rates might be used if the soil is very acid, and lime has not recently been applied. Horticulturalists often have more flexibility in applying lime at lower rates and on a more frequent basis than most other farmers. Supplementary applications of calcium, e.g., calcium nitrate in fertigation programs or as foliar sprays, may be required in some horticultural crops.

Table 3: Suggested Lime Rates (t/ha) for Different Crops. (TS = test strip).

Crop	**pHw**				
	< 4.5	**4.5 – 5.0**	**5.0 – 5.5**	**5.5 – 6.0**	**6.0 – 6.5**
Improved Pasture	5	2.5	2.5 (TS)		
Cereals, Grain legumes	5	3.75	2.5	2.5 (TS)	
Canola, Irrigated lucerne	7.5	5	2.5	2.5 (TS)	
Potatoes	2.5	1.25 – 2.5			
Cucurbits	7.5	5	2.5	1.25	
Other vegetables (tomatoes, brassicas, lettuce)	10	7.5	5	2.5	
Bearing Trees & Vines	7.5	5	2.5		
Before Orchard Establishment	20	10 - 15	7.5	5	2.5

3.2. Aluminium

In acid soils, it is not so much the presence of hydrogen ions that is detrimental to plants, but the presence of high or toxic concentrations of plant available aluminium and manganese, which are more soluble at low pH. Plants vary in their susceptibility to aluminium toxicity. Some crops, such as sugarcane and potatoes, are highly tolerant. Most other horticultural crops, canola and many legumes and are far less tolerant. Table 4 lists various field crop and pasture species according to their tolerance of high exchangeable aluminium concentrations in the soil.

Table 4: Sensitivity to Aluminium (Al)

Sensitivity	**Species**	**% Al of CEC**
Highly Sensitive	Barley, Lucerne, Annual Medics.	1 – 5
Sensitive	Wheat, Canola, Phalaris Seedlings.	5 – 10
Moderately Tolerant	Maize, Rye Grass, Sub and White Clover.	10 – 20
Highly Tolerant	Some Oats, Lupin, Kikuyu, Paspalum.	20 - 30

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Suggested liming rates in sensitive grain crops to reduce potentially toxic aluminium concentrations to a more acceptable level are detailed in the following table.

Table 5: Indicative Lime Requirements in Sensitive Grain Crops.

% Al	< 2 %	2 – 5 %	> 5 %
Lime	Nil	Consider applying lime, e.g., in canola, or a test strip at 2.5 t/ha.	2.5 – 5 t/ha

Higher rates are required in high value horticultural crops, and where the soil is cultivated to a greater depth. In addition to directly affecting plant health, aluminium affects the soil's buffering capacity, i.e., its resistance to change in pH. Aluminium reacts with water to form hydrogen ions, as depicted in the following equations:

$$Al^{3+} + H_2O \rightarrow Al(OH)^{2+} + H^+$$

$$Al(OH)^{2+} + H_2O \rightarrow Al(OH)_2^+ + H^+$$

$$Al(OH)_2^+ + H_2O \rightarrow Al(OH)_3 + H^+$$

Consequently, the higher the aluminium concentration at a given pH, the greater the amount of lime that will be required to achieve the desired pH. Many other factors also affect the buffering capacity, including texture (clays are more strongly buffered than sands) and the amount of organic matter in the soil.

3.3. Manganese

Manganese toxicity may occur at soil concentrations above 50 mg/kg Mn. Liming will reduce exchangeable manganese levels in the soil reducing the solubility of manganese.

3.4. Exchangeable calcium

Different crops require different levels of plant-available calcium for healthy growth. For high value fruit and vegetable crops, levels over 5.0 meq/100 g Ca (1,000 mg/kg Ca) are usually required, whereas for cereal crops or pastures, levels of 2.5 meq/100 g Ca (500 mg/kg Ca) or less may be adequate. The concentration of other nutrients is also of importance. Plants can grow satisfactorily with very low levels of calcium in the soil provided other cations are also at low concentrations. On the other hand, if the concentration of other cations is high, higher levels of calcium are required, i.e., the balance between the cations is of importance.

Considerable variation exists between regions and crops in the critical values for calcium and recommended lime rates. The following table provides a general guide to these recommendations.

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Table 6: Lime recommendations (t/ha) based on ammonium acetate calcium test as performed by the Nutrient Advantage laboratory.

CROP	CALCIUM (meq/100 g)			
Tropical Beef Pastures	0.25	2.5		
	0.5 - 1 (TS)	Variable Responses	Nil	
Nitrogen-Fertilised Grass Pastures (Dairy)	1.0	2.5		
	1.25 (TS at 2.5)	0.5	Nil	
Grass – Legume Pastures, Irrigated Rye Grass	**2.0**			
	TS at 2.5. If pH is low, up to 5 t/ha may be required.	Nil		
Lucerne	**1.5**	**3.0**		
	TS at 2.5. If pH is low, up to 5 t/ha may be required.	TS at 1.0		
Sugarcane	**0.55**	**1.25**		
	2 - 3	1 - 2	Nil	
Grain (legumes & oilseeds are most responsive)	**2.0**			
	2.5 – 5 (Use higher rate in very acid soils.)	Nil		
Cotton	**3.0**	**5.0**		
	1.25 (if pH_w is < 6.0)	1 (TS)	Nil	
Peanuts (Virginia Bunch)	**5.0**			
	If soil is acid, apply 2.5 t/ha lime. Apply Gypsum at 625 kg/ha over the row within 6 weeks of emergence.	Nil		
Potatoes	**2.0**	**3.0**	**5.0**	
	2.5	1.25	1 (TS)	Nil
Vegetables *	**3.0**	**5.0**		
	2.5 - 5	1 – 2.5	Nil	
Trees and Vines *	**2.5**	**5.0**		
	3 - 5	2 – 2.5	Nil	

TS = Test Strip

* Vegetables, Trees and Vines - Use the lower rates on sandy soils, the higher rates on clays.

In sugarcane, lime rates are best determined by the soil calcium test. Sugarcane is responsive to calcium if soil levels are low but tolerates low acidity and high aluminium. In other crops, the soil calcium test should be used in conjunction with soil pH and aluminium tests in determining the need to apply lime and the rate at which it should be applied. Occasionally, there will be a need to augment lime with other calcium fertilisers or use an alternative product if the pH_w is above 6.5 (see earlier

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notes on pH). In high value horticultural crops, Calcium Nitrate is often applied though fertigation systems or as a foliar spray in crops that are susceptible to calcium deficiency, even where lime has been applied to the soil.

3.5. Exchangeable magnesium

The critical value for magnesium varies with the soil type and crop being grown. For highly productive horticultural crops, soil test values above 1.6 meq/100g Mg (ammonium acetate extract) are desirable, while values greater than 0.4 - 1.25 meq/100g Mg are usually satisfactory for improved pastures and grain-crops. For sugarcane the critical value is 0.25 meq/100g Mg. As there are competitive effects at the root surface for plant uptake, the ratio of magnesium to other cations can be just as important as the exchangeable magnesium concentration in predicting where responses to magnesium might occur. A balance with other nutrients (especially potassium) is important. Higher critical values may apply to heavy textured clay soils that have a high CEC (Cation Exchange Capacity) and are high in calcium. Magnesium concentrations often increase with depth. If magnesium is low in the topsoil but high in the subsoil, magnesium deficiency is less likely to occur, or may be temporary. It may be apparent in the seedling stage in annuals, with the crop growing out of the deficiency as the roots explore deeper into the soil. Soils low in magnesium are usually low in calcium and acid. Dolomitic limestone can be used in place of lime on such soils to supply calcium, magnesium and to raise the pH. Similar or slightly higher rates than those recommended for lime can be used. Alternatively, Magnesium Oxide (55 % Mg) can be used in addition to lime.

The following Table lists indicative critical values for magnesium in various crops, and suggested application rates for Magnesium Oxide.

Table 7: Critical Values for Ammonium Acetate Magnesium Test as Performed by the Incitec Pivot Laboratory, and Suggested Application Rates (kg/ha) for Magnesium Oxide.

<table>
<tr><th>CROP</th><th colspan="6">MAGNESIUM (meq/100 g)</th></tr>
<tr><td rowspan="2">Sugarcane</td><td colspan="4">0.1</td><td colspan="2">0.25</td></tr>
<tr><td colspan="2">300</td><td colspan="2">150</td><td colspan="2">Nil</td></tr>
<tr><td rowspan="2">Tropical Beef Pastures</td><td colspan="6">0.4</td></tr>
<tr><td colspan="3">Variable Responses</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">Temperate and Dairy Pastures, Cereals, Cotton</td><td colspan="4">0.4</td><td colspan="2">0.8</td></tr>
<tr><td colspan="2">200 (TS)</td><td colspan="2">Variable Responses</td><td colspan="2">Nil</td></tr>
<tr><td rowspan="2">Grain Legumes, Oilseeds</td><td colspan="4">0.8</td><td colspan="2">1.25</td></tr>
<tr><td colspan="2">200 (TS)</td><td colspan="2">100 (TS)</td><td colspan="2">Nil</td></tr>
<tr><td rowspan="2">Horticulture</td><td colspan="4">0.8</td><td colspan="2">1.6</td></tr>
<tr><td colspan="2">200 - 400</td><td colspan="2">100 - 200</td><td colspan="2">Nil</td></tr>
</table>

TS = Test Strip

Magnesium Oxide is insoluble and should be broadcast on the soil surface early in the fallow period. It is best to wait until after rain has been received to soften and disperse the granules before incorporating it into the soil. Magnesium Oxide is unsuitable for use where a quick response to magnesium is required, e.g., at planting or during the growing season. Magnesium Oxide is most

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reactive in acid soils. It will be slow to react and may be ineffective in alkaline soil. In high value horticultural crops, magnesium sulphate can be applied in fertigation programs or in foliar sprays to augment pre-plant soil-applications of magnesium. In pasture and forage crops, highly productive animals, e.g., pregnant and lactating animals, including dairy cattle, may suffer from magnesium deficiency (hypomagnesaemia, grass tetany or staggers), even though the pasture is growing quite satisfactorily and does not need magnesium fertiliser. Direct animal supplementation may be necessary.

3.6. Buffer pH test

The "Buffer pH" test is used in Qld. to assess the buffering capacity of the soil and in turn to estimate the amount of lime required to increase the soil pH. Strongly buffered soils require more lime to change the pH.

Table 8.

Buffer pH	**< 5.0**	**5.0 - 6.0**	**> 6.0**
Rating	Strongly Buffered	Moderately Buffered	Weakly Buffered

The "Liming Estimates" indicate the amount of fine grade lime of high purity (Neutralising Value above 95%) required to raise the soil pH in the top 10 cm of soil to the desired pH_W (5.5. 6.0 or 6.5). The rates will need to be increased if low purity or coarse grades of lime are used, or the lime is incorporated to a depth greater than 10 cm.

Note: The Buffer pH Test has not been evaluated in States other than Queensland and is not used in sugarcane. Sugarcane tolerates soil acidity but is responsive to calcium. Lime rates in sugarcane should therefore be determined from the soil calcium test.

4. APPLICATION OF LIMING MATERIALS

4.1. Annual crops

Lime should be broadcast on the soil surface as early as possible in the fallow period, at least 2 to 3 months before planting. After application, the lime should be incorporated into the topsoil by cultivation. This allows time for the lime to react in the soil and the pH to stabilise. If applied too close to planting, zinc and other micronutrient deficiencies may be induced in the next crop. If high rates of lime are required and there is not a lot of time left before planting, it will be best to delay planting, or to reduce the lime rate, i.e., split the total, and apply it over two years.

4.2. Pasture

If a new pasture is being established and lime is required, the best time to apply lime is prior to the ground being worked, so that the lime can be incorporated into the soil. In established pastures, time of application is not critical, the application of lime being a long-term investment. However, as the reaction of lime and its movement into the soil is dependent on moisture, it is usually applied just prior to or at the onset of the rainy season. In temperate pastures in southern Australia, lime is normally applied in the autumn, prior to the main growing season. Lime would not normally be applied over summer when groundcover is sparse and the risk of wash from summer storms is greatest. When pastures are grown in rotation with crops, it is best to apply lime during the cropping phase. Lime can

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be slow to take effect in permanent pasture (where incorporation is not possible), particularly if remediation of subsoil acidity is necessary.

4.3. Tree crops and vines

Where a new orchard is to be established, lime should be broadcast at least 2 to 3 months before planting and cultivated into the soil. Quite high rates of lime can be applied at this time, as the soil is worked to a considerable depth. This also allows acidity problems to be rectified at the outset, so that smaller maintenance applications of lime will be all that is required once the orchard is established.

In established orchards, incorporation is not usually possible without disturbing and pruning roots. In the winter-dominant rainfall areas of southern Australia, the best time to apply lime will be the autumn or winter. In deciduous fruit crops, lime is usually applied in the winter. On the New South Wales north coast and in Queensland, spring and early summer will be a better application time. Timing is less critical where irrigation is available.

Lime can be broadcast uniformly on the floor of the orchard but can be directed towards the same area that NPK fertilisers are applied to. This will be the area where soil acidification is occurring at the fastest rate, and it is also the area that the tree roots will be most actively foraging in. Some general guidelines where lime is spread by hand on a "per tree" basis on smallholdings are:

- Apply lime at 250 g/m^2 evenly to the soil under and around each tree, starting 30cm from the trunk to just outside the canopy. This is the area where most of the roots will be found, and the area into which the roots of young trees will grow.

- Alternatively, for mature trees such as citrus, apply lime at 250 g/m^2 in an annulus around the tree, starting 1m from the trunk, out to 2m from the trunk. This is an area of about 10 m^2, so 2.5 kg of lime will be required per tree.

If subsoil acidity has developed in established orchards, lime can be slow to take effect as it takes time to move into the soil profile.

4.4. Sugarcane

Lime is best applied during the fallow period, so that it can be worked into the soil. For plant cane, lime should be broadcast on the soil after harvesting the last ratoon, and then incorporated before planting a fallow cover crop. This allows the lime to react in the soil over the wet season. For plough out and replant cane, broadcast as soon as possible after harvest and before cultivating the land for the first time, in preparation for planting.

5. SOIL STRUCTURE

Poorly structured clay soils often have high concentrations of exchangeable sodium (Na). Such soils are described as sodic. Their structure can be improved by replacing sodium with calcium. Calcium-dominated clays are more friable and better aerated and have a higher water holding capacity.

If the soil is both acid and sodic, lime can be used to raise the pH and to improve soil structure. The lime neutralises acidity and provides calcium (Ca^{2+}) that replaces sodium (Na^+) and hydrogen (H^+) ions on the surface of clay colloids in the soil.

While lime is quite effective in improving soil structure in very acid soils, the closer to neutral the pH is, the slower the lime will be to react. Gypsum, which is more soluble, can be used as well as lime in these situations. The gypsum will have a more immediate effect on soil structure, the lime will correct

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soil acidity and help improve soil structure, but over a longer time frame. Gypsum only should be used to improve soil structure if the pH_w is 6.5 or higher. Lime is ineffective in neutral and alkaline soils. In inland Australia, most sodic soils are strongly alkaline. Lime should not be used on these soils.

6. FURTHER READING

For more information on soil acidity and soil structure, refer to the Incitec Pivot Agritopics on “Soil Acidity” and “Gypsum”.

7. SAFETY DIRECTIONS

Refer to the Safety Data Sheet (SDS) for more detailed safety advice. Before use, read the Product Label and the SDS. Use safe work practices and avoid contact with the eyes and skin. Avoid ingestion and inhaling dust. Protective clothing, eyewear and dust masks should always be used when dealing with this product. Observe good personal hygiene, including washing hands after use. Avoid loss of fertiliser to waterways.

8. WARNING

This document contains information of a general nature. Before using fertiliser seek independent agronomic advice. Fertiliser programs may need to be varied depending on the plants being grown, climatic and soil conditions, application methods, irrigation, agricultural and livestock management practices, the soil’s fertility, and cultural practices. (‘Unforeseen Elements’)

Fertiliser may burn and/or damage crop roots or foliage. Foliar burn to the leaves, fruit or other plant parts is most likely to occur when fertilisers are foliar applied at high concentrations and/or on a regular basis, different products are mixed and sprayed together at cumulatively high rates, the water is of poor quality, or the spray is applied under hot dry conditions, e.g. in the heat of the day.

Fertiliser and supplements may affect animal health. Seek independent advice before using any supplements in livestock rations.

9. DISCLAIMER

As Unforeseen Elements are beyond the control of Incitec Pivot Limited, in no event Incitec Pivot Limited and its related bodies corporate be liable or accept any responsibility whatsoever for any direct, indirect, punitive, incidental, special or consequential damages (including but not limited to loss of revenue, crops and livestock), in respect of the illness, injury or death of a person, damage to property (including of a third party), or any other loss whatsoever arising out of or connected with the use or misuse of this fertiliser, or its transport, storage, handling or application. Where Incitec Pivot Limited and its related bodies corporate’s liability cannot be lawfully excused, it and its related bodies corporate’s liability shall be limited to the replacement of, or cost of the fertiliser supplied. The buyer accepts and uses this product subject to these conditions.

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